

AN ANALYSIS OF LEARNING STYLES IN PODIATRIC
MEDICAL STUDENTS, RESIDENTS, AND PRACTITIONERS

A Thesis

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by

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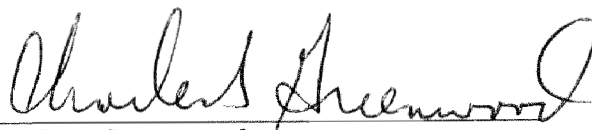
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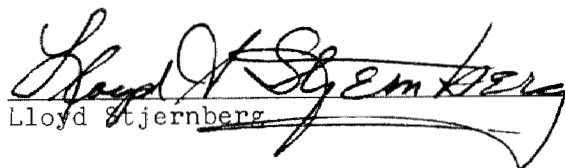
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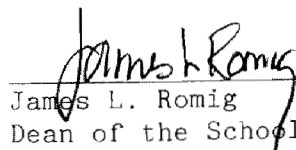
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An Analysis of Learning Styles in Podiatric
Medical Students, Residents, and Practitioners

An Abstract of a Thesis by
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August 1989
Drake University
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The Problem. An attempt was made to determine whether there is any difference or change in learning styles as defined by Kolb in six groups of individuals. These groups were the Oral Examiners of the American Board of Podiatric Surgeons, surgeons who had been in practice at least ten years, podiatric surgical residents and students in the first three years of the University of Osteopathic Medicine and Health Sciences, College of Podiatric Medicine.

Kolb feels that major learning styles are a combination of feeling versus abstract concepts and observation versus experimentation. A numerical score for each category can be determined and utilizing graph placement, a major mode of learning determined.

Procedures. Utilizing grid scattergrams, Chi-Square Tests for the Goodness of Fit, Chi-Square Tests for Independence and Analysis of Mean and Standard Deviation of scores, the data were analyzed.

Findings. It was discovered that all groups learned essentially the same way according to the Kolb Inventory. The exception to this was the Freshman who were tested prior to beginning classes.

Conclusions. A significant finding, however, was that all groups were poor problem solvers, not being able to adequately use all four modes on the Learning Style. They were unable to resolve dialectic tensions between conflicting methods.

Recommendations. In order to better facilitate medical school education, memorizing of facts should be deemphasized and more problem solving should be used as an educational method. This would foster all tenets of adult learning.

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INTRODUCTION

"If you're not having fun doing what you're doing, you probably shouldn't be doing it," and "Everyone should do what they do best." These are hardly deep philosophical thoughts that are the equal of Aristotle, Kant, Socrates, and Kierkegaard. They appear to be more like Peter Pan, Alfred E. Neuman, and Dorian Gray.

But wait, Aristotle, in the *Nicomachean Ethics*, his greatest work in ethics which he dedicated to his son Nicomachus, defined happiness as an activity of the soul in accord with perfect virtue. Happiness is not a static but is a stage of activity and being, and is Maslow's state of self actualization.

Kant, in his categorical imperative, states that every action should be based on that action becoming a universal law. It is distinguished from what he calls "hypothetical imperatives," which is a directive to the effect that if one wishes to achieve such and such an end, one must act in such and such a way.

Kierkegaard, in his Philosophical Fragments, talks about Plato's inquiry of Socrates and whether man can learn what he does not know. If man does not really know something, how will he recognize it when he learns it? Based on this, Socrates reached the conclusion that learning is impossible. That is, it is impossible to acquire true knowledge that one does not already possess. Either one becomes familiar with what one knows, in which case one really doesn't learn at all, or one doesn't really learn because one can't recognize the truth

Kierkegaard did not deny that this problem raised by Plato to Socrates existed, but offered a different solution. Man does not have all knowledge within him. For learning to occur, the moment of learning must then be a unique and strange occurrence. It makes man capable of recognizing a truth he was not able to recognize previously. Knowledge, then, is not a recollection but a transformation that takes place in the learner. Once the transformation occurs, the knowledge is absolute and eternal.

If certain concepts are defined in certain ways, certain consequences will occur. However, one can never be sure of the historical, since matters of fact may only be temporary and are subject to change. Man is, however, forced to make decisions and choices. If he can not be sure about the facts he uses to make those choices, how can he be comfortable knowing he is existentially responsible for those choices? The answer is, he cannot.

Academic physicians wish happiness for students in their lives as physicians. And if one wishes to achieve an end, he or she must act in a certain way. This imperative must be learned by future physicians. If however, the question of knowledge and learning is so complex and uncertain, how does the medical school faculty insure happiness, a logical approach to the patient, and the knowledge to be a good physician?

As of late, the emphasis in medical education has shifted from lectures, note taking, memorization, and multiple choice tests to other

material never comes in contact with the grey matter of the brain. Memorization is short term and is the lowest level of learning, given the fact that there is an overload of content and that multiple choice tests only measure recognition and recall alternatives need to be developed. This type of education measures and creates good medical students, not good physicians. When the students come into contact with patients, they are lost. They have memorized many facts, none of which have been transformed. The student is frustrated, unhappy and feels he or she has learned nothing.

The answer is problem solving. Not only is problem solving the form, it is the content. Medicine is problem solving; it is the activity that is the soul of medicine. It is the directive to the effect that if one wishes to achieve the diagnosis, one must act in exactly such and such a way. Real knowledge is not remembering facts, but the transformation of experience and concepts necessary to accomplish all facets of the problem solving process.

When students have learned this, they will become physicians who will be comfortable and happy doing what they should do best, solving problems.

REVIEW OF THE LITERATURE

The term "learning style" was first used by Thelen in 1954. Since that time, many educators and psychologists have explored the implications of learning styles. Definitions of learning style include a wide range from that of Rita and Kenneth Dunn who defined it as the way individuals concentrate on, absorb, and retain new information or skills to that of Keefe and Languis who define it as a composite of cognitive, affective and physiological/environmental factors that determine how students perceive, interact with and respond to the learning environment (Keefe & Languis, 1985).

In order to understand Kolb's idea of learning style, one must realize that for him learning is experiential. Experiential learning for Kolb is not a molecular educational concept, but rather a molar concept that describes the process of human adaptation to the environment. Kolb's theory of experiential learning is based on the works of Lewin, Dewey, and Piaget. Basically, learning results from the resolution of the conflicts that exist between opposing ways of dealing with the world. These conflicts are called dialectics and refer to the relationships between learning orientations that are mutually opposed and conflicting.

Experiential learning is so called because of the emphasis that experience has in the learning process. It differs from cognitive theories of learning in that there is little emphasis on acquisition, manipulation and recall of abstract symbols. It also differs from behavioral theories that deny the role of consciousness and subjective

generally defined in these terms while Kolb's Learning Style is not. Kolb interpreted Lewin's Model of Action Research and learning as a four stage cycle. Learning is an integrated process that begins with an immediate concrete experience which is the basis for observation and reflection. These observations are used to form abstract concepts and generalizations. These concepts then serve as guides for action in creating new experiences (Kolb, 1984).

For Dewey, learning involved the observation of surrounding conditions, knowledge of what happened in similar situations in the past, and judgments of what they signify. Immediate action is postponed until judgement has intervened (Dewey, 1938).

Learning, or what Piaget called "intelligent adaptation," is the interaction of the process of accommodation of concepts to worldly experience and the process of assimilation of events from the world into existing concepts. If the accommodation process dominates assimilation, then imitation exists and one molds oneself to the environment. Should assimilation dominate accommodation, then play exists which is the imposition of one's concepts without regard for the reality that exists outside the person. When assimilation and accommodation are continual and occur in successful stages, higher level cognitive functioning occurs (Piaget, 1970).

Learning then is a process where concepts are derived from and continuously modified by experience. In the traditional sense of the word, "learning" something makes it a mental habit which is constant.

in the traditional sense, learning is actually nonlearning according to the experiential definitions. Knowing is a process; it is not a "banking" of thoughts and facts. In this theory exposed by Freire, the teacher makes deposits which the students receive, memorize and repeat. In this banking concept, the scope of action allowed to the students consists of receiving, filing and storing the deposits (Freire, 1974).

All these authors described the conflicts between opposing ways of dealing with the world and successful handling of the conflicts as resulting in learning or relearning as one would have it. For Lewin it is the conflict between concrete experience and abstract concepts, and the conflict between reflective observation and action. For Dewey it is the conflict between impulse and reason. For Piaget it is the conflict between accommodation and assimilation.

Learning is then full of conflict between opposing forces of experiential learning. The effective learner is able to resolve this conflict and use all four modes of experiential learning. He or she must be able to involve himself or herself openly in new experiences, utilizing the concrete experience (CE). He or she must be able to observe and reflect on that experience from many different points of view (RO), then develop the ability to form new theories making abstract conceptualizations (AC). These logical theories must then be used to make decisions and solve problems, an active experimentation (AE).

The abstract/concrete dialectic is one of "prehension" according

grasping or taking hold of experience in the world. This is done by comprehension of conceptual interpretation or what Kolb called "apprehension" of the concrete experience. The active/reflective dialectic is one of "transformation" which represents two opposing ways of transforming that grasp of experience. This is done by reflection, a process Kolb calls intention or through active manipulation of the external world, a process called extension (Kolb, 1984). Therefore, learning and knowing require a grasp or figurative representation of experience and some transformation of that representation. A figurative grasp or an operative transformation by itself is not adequate for learning.

Individuals who tend toward extensional transformation are not concerned much with failure or error. On the other hand, those who utilize intentional transformation are most concerned with avoiding failure and error and successful performance is not as important.

Apprehension applies to those that an individual knows without need for rational inquiry or analytical confirmation. These are the things one sees, feels and hears around him. Comprehension, however, applies to the mental model or concept of a sensation, object or experience.

Through choices of experience, people program themselves to grasp reality through varying degrees of emphasis on apprehension or comprehension and program themselves to transform these prehensions via extension and/or intention. The extent to which each individual

individual's particular learning style (Kolb, 1984).

When one emphasizes apprehension transformed by intention, Kolb calls him a Diverger. This person is characterized by imaginative ability. He or she views situations from many perspectives, can generate new ideas and brainstorm. This person is people oriented.

An emphasis on comprehension transformed by extension yields an individual termed a Converger. He or she is opposite the Diverger and is strong in decision making and applying ideas. They are often unemotional and prefer tasks and problems to people.

Apprehension coupled with extensional transformation yields an individual termed an Accommodator. This person excels at doing things, carrying out plans and getting involved in new experiences. These individuals are risk takers, but they tend to solve problems in an intuitive trial and error method. They rely on the information gathered by others rather than their own analytical ability.

The opposite of the Accommodator is the Assimilator who emphasizes comprehension and intensional transformation. This person excels in inductive reasoning, creating theoretical models. The concentration is on concepts and models, not people or the practical value of the concepts.

If one subtracts the concrete experience total from the abstract conceptualization score on the Learning Style Inventory, one has an

totals are subtracted from active experimentation, the extent to which one favors action over reflection is monitored.

Once a particular learning style is developed, it tends to stay basically the same for life. This means that an individual with a particular learning style will often choose a field of study whose knowledge structure is one that prizes and nurtures his particular learning style. Accentuation of that approach to learning is likely to occur. The result is an educational system that emphasizes specialized learning and development through the accentuation of the students skills and interests (Kolb, 1984). Witkin found that when cognitive style matches the demands of a given career specialization, higher performance results. Altmeyer (1966) showed however, that when one accentuates one set of cognitive skills because of an educational process, there is a corresponding loss of ability in the contrasting skills.

This restricts the overall problem solving skills of the student. To be a good problem solver, one needs to identify problems, select a specific problem, consider alternative solutions, evaluate consequences of solutions, select a solution, execute the solution, choose a goal and compare it to reality.

Medical education as it generally now exists accentuates a surface type of learning, that is, memorization for a short term. This process produces an "unlearning" situation in an experiential sense which is evaluated by objective tests stressing recall but not deep process

process where "good students" are rewarded with high grades, which are then seen by residency directors who make choices concerning the selection of residents based on these false markers of future success.

Medical education has been rather constant since 1910 when Abraham Flexner published his report. Granted, the report did much to close many of the then inferior medical schools, but the report became a statue more lasting than bronze and little innovation in medical education occurred for fifty years. Physicians who flourished in this system often became academicians who fostered a continuation of the same system with a self-fulfilling prophetic logic. "It has to be good; look at the lofty and exalted positions we have reached."

After World War II, there was an explosion of medical facts. This explosion continues today and will tomorrow. The first risk takers in medical education were at Case Western University in Cleveland (Williams, 1980). They realized that medical schools were not training physicians for the future, but were concentrating on memorizing facts, emphasizing a non-personal approach to the patients and inadequately evaluating the students. They scrapped the traditional system and began experimenting with less lectures, more patient contact in the early years of school, delayed anatomy lab till later in school, deferred testing, instituted a pass/fail grading system and encouraged research. What happened was that Case Western became a medical maverick viewed with interest but mostly with scepticism. There really was no way to determine if the Case graduates were better, worse or the same.

In 1948, American medical schools begin using The Medical College Admission Test (MCAT) as a significant determining factor in the selection process. At that time, scores were reported in four categories, verbal ability, quantitative analysis, a general information section and science. Scores ranged from 205 to 795 with a mean of 500 and a standard deviation of 100. This was an objective, multiple choice test. The test was used to forecast success in medical school, i.e. would the applicant be a "good student" and someday a "good doctor"? High scores were supposedly predictive of this.

James Bartlett (1967) of the University of Rochester School of Medicine and Dentistry published a paper in the Journal of Medical Education destroying that myth. He found that students one standard deviation below those accepted to the medical school did as well as those with high scores.

In 1973, Wingard and Williamson from the Johns Hopkins University School of Medicine published a review of the literature concerning the accuracy of grades as predictors of physicians career performance. When the literature between 1955 and 1972 was reviewed, it was discovered that there was little or no correlation between medical school grades and performance which was based on different factors by different authors ranging from criteria such as academic appointments (Westling-Wikstrand, Monk, & Thomas, 1970), evaluation of internship performance (Richards, Taylor, & Price, 1962) or board certification (Monk & Thomas, 1970). The authors felt that two of the possible

grades to indicate the transformation of potential and aptitude into accomplishment. Another possibility stated was difficulty with the grading system itself. The authors (Wingard & Williamson, 1973) then say, "the role of the physician, whether practitioner, investigator, teacher or administrator is basically that of the problem solver. The physician must be sensitive to problems and be able to collect adequate data, conduct analyses, draw conclusions, communicate the findings, organize human and technical resources to implement the solution. Since, with few exceptions, grading does not attempt to utilize criteria of this type, it is likely that grading would be deficient in application."

An editorial comment on this article was published in the same edition of this journal (Peterson, 1973). The author stressed that in whatever capacity the physician functions, he must constantly solve problems, a skill medical schools do not measure. Better residencies are awarded to the academically adroit students which have been measured by a fallible system. Medical schools exhibit a commitment to elitism by continuing to do this.

Perhaps both cognitive and noncognitive measures are needed to measure future performance of medical students. This concept has been explored in a paper by Keck, Arnold, Willoughby, and Calkins (1979). They found that when multiple regressions were performed on such noncognitive predictors as Holland (1971) "Self Directed Search," The Omnibus Personality Inventory, a personal interview and performance

clinical performance and really measured cognitive skills.

Problem Solving as a Solution

The most likely origin of "Problem Solving" in the medical education literature dates to Williamson in 1965. He tried to measure the clinical judgement of medical students but was relatively unsuccessful. In 1966, McGuire from the University of Illinois at Chicago published an early and somewhat basic manuscript on problem solving in medicine. It proved to be interesting to risk takers such as McMaster University, the University of Southern Illinois, and the University of Illinois at Chicago.

Through the seventies, "problem solving" evolved into three basic concepts: (a) the problem solving approach which studies clinical reasoning from an information processing standpoint; (b) the judgement approach which utilizes correlational statistical models; and (c) the decision-analysis approach which investigates choice under conditions of uncertainty that necessitates estimating, and manipulating complex probabilities (Elstein & Bordage, 1979).

Most studies and almost all problem solving implementations have focused on clinical reasoning from an information processing standpoint. It is important to differentiate information processing from information gathering as proficiency is distinguished from efficiency.

Barrow and Tamblyn (1980) who were originally at McMaster

and manage a patient's medical problems." Again, the emphasis is on information processing. However, they feel that the process for correct clinical reasoning can be learned in a conscious, systematic manner and that if medical schools and faculties would deemphasize the collection of facts that has become compulsive, the whole process could be facilitated.

The terms "cognitive process" and "clinical reasoning from information processing" have been used to define or describe the problem solving process, but what really does that mean?

Most authors who have investigated the nature of problem solving in medicine have come up with four generic steps (Barrow, Norman, Neufeld, & Feightner, 1982) in the process (Elstein & Bordage, 1979). It begins with an initial impression or concept. Second, a limited number of hypotheses are constructed. In step three, these hypotheses are used to collect additional data, and finally, the data collected is used to verify, revise or reject the hypothesis. This is a hypothetical deductive method for making a diagnosis or placing a label on some problem.

If one remembers back to the Kolb Learning Style Inventory, the ability to form hypotheses and deduce an answer or solve a problem is characteristic of the assimilator and converger, the two quadrants beneath the X axis. To refresh one's memory, both have abstract conceptualization as the characteristic mode of apprehension. The

modes and, indeed, of the 272 who took the Inventory, 170 or 66% were in those categories and therefore this study is over.

Two questions however remain to be answered. Is what has classically been termed problem solving really problem solving, or is it merely and really identification of a particular problem and putting a name on it? And just exactly how does one generate a hypothesis?

An analogy that illustrates these questions may help. A man is walking through the woods and stumbles upon a snake. He hypothesizes that the snake could be harmless or deadly. Hearing the rattling noise, he deduces that this is indeed a rattlesnake. Has he solved the problem?

Absolutely not. This individual's problem is just about to begin and secondly, how does he know that this is a snake and that the rattle means something? It could be a frog and the rattle a woodpecker or a gypsy. This individual remembers what both snakes and frogs look like and what woodpeckers or gypsies sound like. He's in the woods, the animal is in a sunny spot, it's not winter and the critter has fangs. These things were known instantly along with many others about the situation. There was no need for rational inquiry or analytical confirmation. They were there, grasped through a mode of knowing called apprehension. This is an intuitive perception of a sensation that the individual perceives as reality. He feels this is a rattlesnake and he did not have to consult a book.

rattlesnake has done little for this individual. What he really needs to do is logically find a solution and execute it.

Here he needs his divergent skills, i.e. his intuition, his feelings about the snake's mood, recognize the problem inherent in trying to kick the snake to death, or realize the implications of trying to grab the snake with his hand. He also must imagine the implications of just standing there. His reflection on these thoughts is accomplished by grasping this concrete experience via apprehension, and transforming it via intention to a reflective observation in order to begin this theorizing.

After he has logically deduced a solution, more than just naming it a rattlesnake, he must put that solution into action utilizing his accommodative skills. The obvious solution to the problem is to shoot the snake, but this is not possible. He has no gun; back to divergent thought.

Suppose he has a gun and pulls the trigger and misses or nothing happens. Does he run, throw the gun, or pull the trigger again? What he really should do is start the process all over again. If he panics and chooses the wrong action, he can die.

As assimilation is integrative analysis, divergence is integrative synthesis, and as convergence is discrete analysis, accommodation is discrete synthesis (Kolb, 1984) doing the one most correct thing to solve the patient's problem.

The literature has no articles that are highly critical of the problem solving approach to medical education. The biggest problem is showing that problem solving as a method of learning is any better than conventional methods. Again, it has been difficult to assess. Graduates have been largely supportive of this type of medical education (Woodward & McAuley, 1981). However, the student who is not an independent learner finds the situation quite stressful in the beginning. "Am I doing as much as I should?" "Am I on the right track?" "Do I have the right answer?" These are familiar questions for those new to the system. The irony is that to be an independent learner, one must use all the facets of the Kolb Learning Style, thereby manifesting integrative development as opposed to specialized development of one or two learning styles (Kolb, 1984).

DESIGN OF THE STUDY

The Kolb Learning Style Inventory (Kolb, 1976) was administered to 272 individuals who comprised six groups. These groups were as follows:

1. The American Board of Podiatric Surgery Oral Examiners,
n = 42
2. Podiatric surgeons who were not Oral Examiners but had
been in practice at least 10 years, n = 43.
3. Podiatric surgical residents, n = 37.
4. The University of Osteopathic Medicine and Health
Sciences, College of Podiatric Medicine, Classes of
1990, n = 61, 1991, n = 43 and 1992, n = 46.

There are certain reasons each of these groups was included in the study. The Oral Examiners are individual surgeons who are generally perceived as elite within the profession. Included in this group are residency directors from renowned programs, Chiefs of Surgery at the Universities and often published physicians. They present an image of "well learned," and it would serve the experiment to investigate whether their particular learning styles differed from others.

The surgeons in practice represent the nuts and bolts of the

education most often means journal reading and attending seminars usually given in lecture form by the group that makes up the Board Examiner category. The form of instruction is a lecture with perhaps a question and answer session. It imitates the medical school environment but without a test. How do these practitioners differ in their learning styles after years in private practice?

Residents are the future of any medical specialty. They are academic, curious, driven to learn without the fear of examinations and have a purity of intention. They are at once sophmoric and the impetus that keeps the trainers current in their knowledge of the literatute.

They are in a unique position, having the time to daydream, the opportunity to theorize, the obligation to logically treat and the chance to operate for the first time. They feel with the patients more than they felt as a student. They can observe the hospital and patients around them and reflect. They can make abstract concepts but yet be extremely active. If any group should depict what problem solving really ought to be, this is it.

The students were chosen because they are within the foyer of the medical profession. As novices, they bring what they have learned in undergraduate school and through life's experiences. Do they change as they progress, do they learn to solve problems, or do they merely memorize and forget? Does the medical education system foster good future physicians or good students?

1989. The Board Examiners took the Inventory at the Board Certification examinations in Chicago during June of 1988. The practitioners took the Inventory during the year at various seminars the investigator lectured at during the year. Residents ranked their choices when the author visited various residency programs throughout the country during that year. The Class of 1992 was tested during orientation in August of 1988. The Class of 1991 was tested in March of 1989 during their second year of school, and the Class of 1990 in June of 1988 just prior to their first clinical experience during the summer between the second and third years of school.

Administration of the Inventory was done prior to explaining any significance or application to medicine, learning styles or the problem solving process. Participants were told to rank the endings for each sentence in a particular row from 1 to 4, with "4" indicating the sentence ending that he or she felt most comfortable with or liked best. A response of "1" was used to indicate a sentence ending that referred to the way that seemed least like the way he or she learned. The response of "3" was closest to "4" and "2" closest to "1". Participants were advised that the choice of any number was not to be repeated in any row. The Inventory took approximately 15 minutes to administer. Participants then totaled each column then subtracted the total of Column 1 (Concrete Experience) from Column 3 (Abstract Conceptualization) and the total of Column 2 (Reflective Observation) from Column 4 (Active Experimentation). Totals for each were plotted on the Cycle of Learning to determine percentiles for each phase of the

learning styles were then explained to the participants and questions answered. The explanation was aided by slides which were made to simulate the various cycles and grids.

The Inventory itself was collected from all participants and the calculations checked and point placement on the grid recalculated and the position placed on a new grid where all members of each group were recorded to depict closeness to the X axis Y axis intersection and ability to effectively use all facets of the problem solving process.

The number of participants in each quadrant was then counted and the result analyzed for Goodness of Fit and intergroup relations for independence using the Chi-Square statistic.

Means for column scores and differences for axis scores were calculated for each group. The groups were then compared to each other using T-tests for significance between groups.

Charts depicted quadrant classification, frequencies, and means and standard deviations are included in the data section.

ANALYSIS OF DATA

Learning-Style Type Grid Scattergram

Each of the 272 adults involved in the medical school experience or practice who took this Inventory received an X axis score; Active Experimentation minus Reflective Observation and a Y axis score; Abstract Conceptualization minus Concrete Experience. The resultant score places the individual in one of the quadrants (preferred learning style) or on one axis or at the intersection of both axis.

For the practice of medicine, it may or may not be important what quadrant one ends up in because with this inventory, as with life itself, everyone has to be somewhere. Dr. Kolb has implied that in order to solve problems in an efficient and proficient manner, one must utilize the skills in all four quadrants, which means that the dialectic between Concrete Experience and Abstract Conceptualization as a means of prehension, and the dialectic between Reflective Observation and Active Experimentation should cancel one another, placing the individual at or near the intersection of the axis of the grid.

Mere categorization in one of the four quadrants does not allow for cognition of intersection approximation. Points were plotted for each of the six groups tested on separate grids so that the number of students or physicians whose learning style is near the intersection could be calculated. The 33rd to 66th percentile on each axis was used. This approximated the middle third of each axis, which went from 11 to -1 on the X axis and from -1 to 10 on the Y axis. The number of

possessed the ability to use all four learning styles in problem solving.

Listed in Table 1 are groups, number of respondents in each group, and number and percentage within the 33rd to 66th percentile.

It appears that the group that relies most on feeling and concrete experience, the Class of 1992, has the greatest number in the middle percentiles. The groups that relies most on Abstract Conceptualization and Reflective Observation, the Board Examiners and Residents, have the fewest physicians with problem solving skills that involve the modes of the Learning Style Inventory in somewhat equivocal amounts.

Chi-Square Analysis

I. Within Group Distribution

H_0 The observed frequencies for learning styles within each group will not differ significantly from the expected frequencies for that group.

H_1 The observed frequencies for learning styles within each group will differ significantly from the expected frequencies for that group.

Using the Chi-Square Test for the Goodness of Fit, the above null hypothesis was tested. For a degree of freedom (df) equal to 3, where $df = C-1$, and an alpha level of .05, the critical value is 7.81. Where the df equals 3 and the alpha level selected is .025, the critical value is 9.35. Listed in Table 2 are the observed frequencies (f_o) for

Table 1. Grid Scattergram Percentile Ranking

Group	Number In Group	Number in 33-66 Percentile	Percent in 33-66 Percentile
Board Examiners	42	4	9.5
Practice more than 10 yrs	43	5	11.6
Residents	37	3	8.1
Class of 1990	61	7	11.5
Class of 1991	43	5	11.6
Class of 1992	46	7	15.2

Table 2. Categorization of Subjects According to Learning Styles

GROUP	DIVERGERS	ASSIMILATORS	CONVERGERS	ACCOMMODATORS
Board Examiners (43) $f = 10.5$	6	17	14	5
Nonexaminers 10 Yrs Practice (43) $f = 10.75$	2	14	16	11
Residents (37) $f = 9.25$	4	15	9	6
DPM Class of 1990 (61) $f = 15.25$	8	22	21	10
DPM Class of 1991 (43) $f = 10.75$	4	14	16	9
DPM Class of 1992 (46) $f = 11.5$	<u>17</u>	<u>11</u>	<u>8</u>	<u>10</u>
TOTALS: 272	41	96	84	51

Analysis of the Goodness of Fit

1. Board Examiners

The expected frequency for each of the four categories is $f_e = 10.5$. The Chi Square is $\chi^2 = 9.98$ which is in the critical range at the .025 alpha level, $\chi^2 (3, n = 42) = 9.98, p < .025$. There are abnormally high numbers of examiners falling into categories below the transformation axis of the Learning Style. These two categories, Assimilators and Convergers, are equated with high comprehension skills. Conversely, there are very low scores for the apprehension

axis of the Inventory which may indicate an absence of feeling in the learning. Rather, critical thinking and abstract conceptualization seems to be the preferred method on the prehension scale. More individuals transform this knowledge via intention, making them assimilators rather than transforming via extension making them convergers. The examiners seem to excel in theory and deductive reasoning as opposed to accommodators and divergers, who would be more comfortable performing or brainstorming new ideas.

2. Private Practitioners

The expected frequency for each of the Kolb Learning Style Inventory categories for those in private practice more than ten years is $f_e = 10.75$. The Chi Square is $\chi^2 = 10.66$ which is in the critical range at the 0.25 alpha level, $\chi^2 (3, n = 43) = 10.661, p < .025$.

The private practitioners have an abnormally low number of
 practitioners indicating a lack of imagination as a frequently used

logical approach to comprehension and extension, while almost an equal number opted for transformation of comprehension via intention into the Assimilator category indicating strong theorizing skills.

3. Residents

The expected frequency for each of the four categories in the Residents group is $f_e = 9.25$. The Chi Square is $X^2 = 12.38$, which is in the critical range at the .01 alpha level, $X^2 (3, n = 37) = 12.38, p < .01$.

Residents appear very high on the assimilator scale, emphasizing their ability to learn by making theories of what they have observed and comprehended. As in all the groups tested except the Class of 1992, the residents have weak divergent skills. Their abilities for free flowing thought have been hampered. As a group they approach the f_e for the Converger category, but are below the f_e for the Accommodator category.

4. Class of 1990

The expected frequency for each category is $f_e = 15.25$. The Chi Square is $X^2 = 10.38$ which is in the critical range at the 0.25 alpha level, $X^2 (3, n = 61) = 10.38, p < .025$.

The Class of 1990 appears to have much the same Inventory as the Residents and the Class of 1991. There are only half the number of Divergers and slightly more than half the Accommodators one would

have any application for their assimilating abilities or may be too hasty in the decision making Converger skills.

5. The Class of 1991

The expected frequency for each of the categories is $f_e = 10.75$. The Chi Square is $X^2 = 8.05$ which is in the critical range at the 0.5 alpha level, $X^2 (3, n = 43) = 8.05, p < .05$.

Analysis of this group of students shows almost the same frequency distribution as the Class of 1990. The number of students in the lower half of the grid is out of proportion to the number in the upper half of the grid, indicating more students with abstract conceptual learning instead of concrete experiential learning.

6. The Class of 1992

The expected frequency for each of the categories is $f_e = 11.5$. The Chi Square is $X^2 = 3.9$ which is not in the critical range, $X^2 (3, n = 46) = 3.9, p < .05$.

Analysis of the group shows a very equal distribution of individuals across the categories with the only outstanding exception being in the Diverger category, where the number of students is at least double the number of Divergers in any other group. This Inventory was distributed during orientation before classes began and reflects learning style choices prior to medical school exposure where the ability for divergent thought may be stifled.

This somewhat equal distribution does not mean that each individual possess all prerequisite skills for the problem solving process, but that within the class are individuals distributed in each of the four categories and that there are an equal number of Divergers who are imaginative and understanding who possess the ability to recognize problems. The question is whether or not this ability is lost as one progresses through school toward practice.

The Chi-Square Test for Independence

H_0 For the population of practitioners and medical students tested by the Kolb Learning Style Inventory, Inventory category ratios are independent of position within the profession.

H_1 The frequency in each category is related to position within the profession.

With degrees of freedom = 3 and an alpha level of .05, the critical value for Chi-Square (χ^2) is 7.81.

Analysis of data in Table 1 in different combinations reveals the following:

1. When the Board Examiners are compared against the non-examiners who have been in practice at least 10 years, $\chi^2 (3 \text{ df} = 85) = 4.66, p < .05$

∴ fail to reject H_0

2. When the Board Examiners and non-examiners are compared as a group against the combined Classes of 1990, 1991, and 1992:

$$\chi^2 (3, n = 235) = 4.63, p < .05$$

\therefore fail to reject H_0

3. When the Residents are compared against the combined Classes of 1990, 1991 and 1992:

$$\chi^2 (3, n = 187) = 4.3, p < .05$$

\therefore fail to reject H_0

4. When the Residents are compared against the Board Examiners combined with the practitioners:

$$\chi^2 (3, n = 122) = 5.12, p < .05$$

\therefore fail to reject H_0

5. When the practitioners are compared against the Class of 1992:

$$\chi^2 (3, n = 89) = 24.28, p < .05$$

\therefore reject H_0 and accept H_1 for these two groups

6. When the Class of 1991 is compared against the Class of 1992:

$$\chi^2 (3, n = 89) = 11.01, p < .05$$

∴ fail to reject H_0

From the data collected and the Chi-Square Test for Independence, it can be concluded that the Class of 1992 is the only group tested that does not have the same shape for all categories as the other groups. In other words, Board Examiners, non-examiners in practice more than 10 years, residents, the Class of 1990 and the Class of 1991 have essentially the same frequency distribution in each of the four Learning Style Inventory categories. Therefore, Learning Styles, excluding those who have not yet begun medical school, are independent of position within the profession.

Analysis of Mean and Standard Deviation

Utilizing the commonly accepted method, the means and standard deviations of each column (Concrete Experience, Reflective Observation, Abstract Conceptualization and Active Experimentation) and differences in dialectic axis (Abstract Conceptualization - Concrete Experience and Active Experimentation - Reflective Observation) were calculated.

Analysis of the Concrete Experience column revealed that the Class of 1990 scored at the 29th percentile for the normative group, while the Class of 1992 scored at the 69th percentile. The other four groups were between the 41st and 48th percentile.

Reflective Observation category when measured against the national norm.

Within the Abstract Conceptualization Category, the Class of 1992 was the lowest when compared nationally with a percentile score of 50%. The Board Examiners scored the highest in this category ranking at the 73rd percentile. The remaining groups were clustered at the 67th percentile.

Analysis of the Active Experimentation category revealed three groups clustered at the 50th percentile; those who had been in practice at least ten years and the Classes of 1990 and 1991. The surgical residents were at the 38th percentile, the Board Examiners at the 35th percentile and the Class of 1992 fell in the 33rd percentile.

Cursory examination of the mean scores reveals that the majority of scores are within the 40 to 60% range for the national norm. There are, however, three glowing exceptions. Within the Active Experimentation column three groups felt they learned well by "doing" at less than the 39th percentile. The Freshman class, the Class of 1992, was at the 32nd percentile, meaning they felt that prior to the first day of classes, this was their lowest ranking compared to the national norm for learning priorities. Obviously, the "doing" method of learning had not been perceived as particularly successful. What is surprising about this group is that they scored the highest in this population for learning by Concrete Experience which is more a

The Board Examiners for the American Board of Podiatric Surgery were at the 34th percentile on the Active Experimentation scale of the Inventory. These surgeons, many of whom have taught and authored scientific publications, appear to learn better by abstract conceptualization, that is by "thinking" rather than by "doing."

Surgical residents were in the 39th percentile of the Active Experimentation scale. Although this is the period of their professional careers where "hands-on" training has been deemed important, especially by residents themselves, they have not chosen this mode of learning to the degree they often verbalize. They continue to learn best by watching and developing theories after looking for the meaning of things.

On the Abstract Conceptualization scale, 5 of the 6 groups are between the 63 and 75% percentile. These are the Examiners, Practitioners, Residents and Classes of 1990 and 1991. These groups appear to be logical and systematic but are often lacking in sensitivity to feelings and people. The group that had the lowest mean score on the Abstract Conceptualization scale, the Class of 1992, was at the 50th percentile but, conversely, they were at the 67th percentile on the Concrete Experience scale indicating that they learn well from specific experiences, relate well to people and are sensitive and feeling. The question to be asked is whether these students become analytical, systematic and logical at the cost of personal involvement, open-mindedness and adaptability to change. Since the remaining five

these students that alters the learning style?

Analysis of T-Test Results for Significant Findings

Between Groups Tested and Modes of the Learning Style

1. Board Examiners vs Active Practitioners

Those individuals who are in active practice prefer to learn by doing at a statistically greater rate than the board examiners. After years of practice, the need for cyclic, systematic problem solving skills are often lost and conditions are easily recognized and treated without the need for histories, reviews of systems and physical exams to establish a differential diagnosis and proper techniques to rule out certain conditions.

A problem may arise, however, when the practitioner sits for the oral examination to become Board Certified. Within a short period of time, the skills of the problem solving cycle are needed to solve a problem where little information is gratuitously given, and histories and exams of the patients are required rather than just "doing the right thing" for the patient. Perhaps Board Review Courses should focus on the process of problem solving instead of numerous facts and categories.

2. Board Examiners vs Residents

The dialectic of Active Experimentation-Reflective Observation refers to the conflict between the intentional or extensional transformation of learning experiences. The Active Experimentation portion of the axis reflects the extensional portion of the dialectic,

failure or error, while being oriented toward intentional transformation (Reflective Observation) is associated with a primary concern about avoiding failure and error and a willingness to sacrifice opportunities for successful performance in order to do so (Kolb, 1984).

Many of the Board Examiners are also trainers of residents and all too often have seen residents who need to be kept under tight reigns because of the tendency to "want to try something new," which may not be the accepted standard of care. The trainer is ultimately responsible for the resident and tends to be more conservative.

3-4 Board Examiners vs Classes of 1990 and 1991

Again, students have very little responsibility and are constantly wanting hands-on experiences and patient contact. They have had learning experiences which have consisted of rote memorization and passive experiences. For students, the learning experience is not fun and seems to be of little value without some "doing" of Active Experimentation. In order to accomplish this portion of the experiential learning cycle when the student is not yet ready to really care for patients, the utilization of problem solving learning, patient simulations and patient management problems could be used to enhance active learning and foster problem solving skills which require all modes of the Learning Cycle.

confirmation. They are able to simply "feel" the concrete experience. The Board Examiners, however, are much more analytical and logical, but this is at the expense of great imagination and risk taking.

The dialectic tension between Concrete Experience and Abstract Conceptualization also reveals that as a group, the Board Examiners require strict comprehension of apprehended sensations, while as a group the Class of 1992, being in the feeling portion, may ignore certain aspects of the sensation which may be quite important.

6. Active Practitioners vs Residents and Students

Those individuals in practice for more than 10 years seem to rely on Active Experimentation more than Residents. Residents are in a highly academic setting, therefore being more reflective, while the experience of practice allows the practitioner the luxury of vectoring a diagnosis and treatment without significant reflection or observation.

7. Active Practitioners vs Class of 1992

Again, the Class of 1992 exhibits significantly more individuals who have concrete experience as a major learning mode, while the practitioners are the opposite. They grasp via comprehension and transform their comprehension via active experimentation to a statistically greater degree than the Class of 1992.

8. Residents vs the Class of 1991

actually getting a free hand as a surgeon. The resident, having seen the procedures in three dimensions, begins to develop the ability of foreseeing the upcoming operation in his mind and can reflect on the possible outcomes and intraoperative complications. Residents begin to make theories via reflection on what has been grasped.

Students of the Class of 1991 have no clinical experience upon which to reflect. They are frustrated by lack of activity and feel they would learn better by doing something rather than merely memorizing facts.

9. Active Practitioners vs Class of 1993

The practitioners continued to show a heavy reliance on Active Experimentation as opposed to the Class of 1990. The Class of 1990 was much more reflective than the busy, experienced practitioner who cut quickly to a diagnosis.

10. Residents vs Class of 1992

The difference between the Residents and the Class of 1991 was one of the transformation of apprehension or comprehension via intention or extension. The difference between the Residents and the Class of 1992 is that of how the taking hold of experience of the world happens. The Residents seem to do it by abstract concepts, while the Class of 1992 has a statistically significant number of individuals who do it via the felt qualities of immediate experience.

mode than is the Class of 1991 but they are more reflective, beginning to view things and situations from different viewpoints becoming more critical.

12. The Classes of 1990 and 1991 vs the Class of 1992

Quite simply, the Class of 1992 is a group that relies on tangibly felt immediate experience as opposed to reliance on conceptual interpretation and symbolic representation as the Classes of 1990 and 1991 do.

The Class of 1992 transforms the experience more by intention (Reflective Observation) than the Class of 1991, but not the Class of 1992. Both the Classes of 1990 and 1991, however, transform their comprehension via extension (Active Experimentation) more than does the Class of 1992.

Table 3. Learning Style Inventory Scores for the Research Population

GROUP	CONCRETE EXP (CE)		REFLECT OBS (RO)		ABSTRACT CON (AC)		ACTIVE EXP (AE)		ABSTRACT CON (AC-CE)		ACTIVE REF (AE-RO)	
	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD	\bar{X}	SD
Board Examiners N = 42	23.71	8.40	29.31	6.54	34.07	8.00	32.10	6.18	11.05	15.09	3.79	11.36
Active Practice of more than 10 yrs N = 42	23.28	6.62	28.42	7.47	32.54	7.38	35.67	6.00	9.26	12.24	8.58	11.13
Surgical Residents N = 37	23.38	6.59	30.27	8.42	32.95	6.11	33.32	6.27	9.97	11.20	4.65	12.95
Class of 1990 N = 61	21.81	5.66	30.30	6.45	32.38	7.99	35.59	6.64	8.33	12.26	4.97	10.66
Class of 1991 N = 43	24.35	5.55	27.42	7.35	32.70	6.30	35.51	6.92	8.54	9.73	7.60	12.77
Class of 1992 N = 46	28.50	9.40	30.45	6.61	29.50	6.88	31.78	8.05	.04	12.56	.50	11.74

Tests for significance between groups (1 tail, only probabilities .025 are shown)

Board examiners vs active practitioners, AE, $p < .005$

Board examiners vs residents, AE-RO, $p < .025$

Board examiners vs class of 1990, AE, $p < .005$

Board examiners vs class of 1991, AE, $p < .01$

Board examiners vs class of 1992, CE, $p < .005$; AC, $p < .005$; AC-CE, $p < .005$

Active practitioners vs residents, AE, $p < .05$

Active practitioners vs class of 1990, AE-RO, $p < .05$

Active practitioners vs class of 1992, CE, $p < .005$; AC, $p < .025$; AE, $p < .005$; AC-CE, $p < .005$; AE-RO, $p < .005$

Residents vs class of 1991, RO, $p < .05$; AE, $p < .05$

Residents vs class of 1992, CE, $p < .005$; AC, $p < .005$; AC-CE, $p < .005$

Class of 1990 vs class of 1991, CE, $p < .005$; RO, $p < .01$

Class of 1990 vs class of 1992, CE, $p < .01$; AC, $p < .025$; AE, $p < .005$; AC-CE, $p < .005$; AE-RO, $p < .025$

Class of 1991 vs class of 1992, CE, $p < .005$; RO, $p < .025$; AC, $p < .01$;

AE, $p < .01$; AC-CE, $p < .005$; AE-RO, $p < .005$

SUMMARY

This study attempted to investigate learning styles as defined by Kolb and his Learning Style Inventory in hopes of discovering that over the course of years of exposure to the surgical profession, there was a change in learning styles to the accommodator quadrant or that surgical residents, because they were accommodators, chose surgical residencies.

The null hypothesis stated that there was no difference in the learning styles as one progressed through the profession in years of experience. In five of the six groups tested, the statistics failed to allow the null hypothesis to be rejected. Only the first year medical students, the Class of 1992, differed significantly from the other five groups. The Class of 1992 showed less than expected frequencies in the categories of assimilators and convergers and more in the diverger category than the other five groups. Although the divergers ranked high for the Class of 1992 by itself, the other categories were statistically less than expected values. Failure to reject the null hypothesis results in the conclusion that there really is no alteration in learning styles as one progresses in years in the medical profession. This was not a longitudinal study, but studied different groups over the course of the same calendar year, but the similarities in distribution for all the groups leads one to believe that assimilators and convergers comprise the majority of learning styles in this surgeon and surgeon-to-be study, which contradicts the conclusions made by Plovnick (1985), Kolb (1984) and the Linn and Zeppa (1980) studies. Their studies found that surgeons were accommodators, but this study found them to be assimilators and convergers instead.

divergers, leading one to believe that having a particular style does not necessarily channel one into a particular career choice, nor do those already in that career have a statistically high proportion in any one category.

While plotting scores for the Kolb Learning Style Inventory, it was sometimes astonishing to see scores with exceptionally high absolute values in certain categories. This prompted a scattergram representation of the scores for each group and assessment of the number of respondents that fell within the middle third on each axis. Positions in this area represented individuals who would be adept to using all facets of the Learning Style Inventory, (i.e. Concrete Experience, Reflective Observation, Abstract Conceptualization and Active Experimentation) in the problem solving process.

Results showed poor problem solving skills for the vast majority of this population. This confirmed Kolb's theory of accentuation whereby an educational process that stresses one set of cognitive skills also appears to produce loss of ability in the contrasting set of skills. As one progressed through the profession, point plotting in the graph moved farther from the X axis, Y axis intersection exhibiting this phenomenon. Throughout the sample population, problem solving skills seem poor.

Throughout Kolb's work, he analyzes the four quadrants of the Learning Style Grid. It only happens that people must fall in one of

intersection of the X and Y axis utilizes all facets. This incidentally is impossible, for there are no whole numbers at the intersection and the Learning Style Inventory only deals with whole numbers.

There is a saying in the medical profession that "surgeons know nothing and do everything; internists know everything and do nothing. Psychiatrists know nothing and do nothing, and pathologists think they know everything and can do everything." This saying was probably around long before Kolb and really does reflect certain personalities of specialties within medicine. If one places psychiatrists in the divergent quadrant, pathologists within the assimilator quadrant and surgeons in the accommodator quadrant, contemplation of these personality types correspond to descriptions offered by Kolb for the Learning Style Inventory.

Unfortunately, they are more psychological descriptions than cognitive descriptions. What, then, is the use of the Kolb Learning Style Inventory, especially in medicine? Is it an ethereal exercise meant for assimilators who like to make up theories that may not have any relevance in the real world? Has anything at all been learned in this study?

People tend to equate Kolb with the four terms of the Learning Style Inventory. The Inventory is really not about being in one of

... but everyone has to be somewhere.

changing the person of the paper because what follows is experiential for him) Kolb is on a much higher level. His readers only make it through the four categories. Even Kolb offers suggestions on how to strengthen the weak styles. It's not necessarily good to be strong in a quadrant. That individual may seem happy, but they are closed minded, stubborn, unwilling to change, and not self directed adults.

What Kolb is really saying is that acquiring the ability to use all facets of the grid, Concrete Experience, Reflective Observation, Abstract Conceptualization and Active Experimentation, one becomes an adult, self directed, independent learner who is first and foremost an adroit problem solver. Medicine is a series of problems, not just making a diagnosis but healing the illness, especially when it's not easy, not just from a medical point of view, but from a socioeconomic point of view.

We know that medical education cannot continue in the mode it has been in. Not only are there too many facts to remember, this memory is short term and superficial. The facts are gone almost overnight.

The answer is not a quick fix change in the curriculum. It is in a change in attitude, not of the student but in the faculty and institutions. We have said the main problem with medical schools is that they lead to a degree and the students leave. Quite honestly, we're lucky they don't leave earlier.

social satisfaction for a long term goal, and are willing to work hard. They are adults but we treat and teach them like children in what essentially amounts to a tenth grade atmosphere.

Incorporating all that has gone before in this thesis, it only seems natural to change medical education to something that is useful for the students, treating them like the adult learners that they are. This is a huge change from the status quo, but in reality is the implementation of the Kolb Learning Style and Experiential Learning in a problem solving format for adults.

Having seen through this study that the population was poor at problem solving, which is really what they do as physicians, this is a most logical step.

Problem solving eliminates the intellectual elitism that accompanies the pedagogical principle that "I as professor know everything that you as student need to know."

The environment changes to a comfortable one from the sterile intimidating one of the medical school. Faculty are personable, becoming more appropriate role models in a problem solving curriculum that functions in a small group format.

There is no magic moment when medical students all of a sudden

... have their first clinical experience.

practice problems. Or, they learn to diagnose and treat by practicing and learning these skills by doing it in their minds and on paper.

They'll find the library; they find the facts they need to know. They'll experience the patient situation, they'll be inductive, they'll hypothesize, they'll be deductive and come up with a plan of action which has an effect that must be evaluated and the cycle starts over.

This is the real Kolb higher level experiential learning cycle of the adult. This is what he meant to evolve, a generic style of learning that leads to self directedness and self actualization. However, the process doesn't happen by itself. We as medical educators must facilitate the process by allowing the students to problem solve in an atmosphere where form is more important than content, where mistakes are not ridiculed but the risk taken after utilizing all facets of the learning style are praised.

Years ago it was the accepted standard of care to put heat on an acute musculoskeletal injury. Today this is contraindicated and cold is the treatment choice. Even in a such a simple matter, the fact of knowledge, cold vs hot, has changed. The facts are not absolute and unchanging. The process of solving problems is.

I know this works, not just intuitively, but experientially. In the few courses where risks have been taken and the curriculum changed to a small group problem solving format, the results have been

life long learning habits.

Most importantly, they really enjoyed the process and looked forward to coming to the small group. They learned to use their knowledge experientially as Kolb espouses and doing something they must do well and do the rest of their lives, solve problems.

After all, "if you're not having fun doing what you're doing, you shouldn't be doing it" and "everyone should do what they do best." Kolb would agree.

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